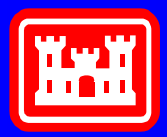
DOD Experience from a Half Million Operating Hours of a PAFC Fleet

William R. Taylor
Dr. Michael J. Binder
Franklin H. Holcomb

2000 Fuel Cell Seminar
Portland, Oregon
November 1, 2000

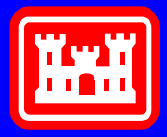


US Army Corps
of Engineers

Engineer Research & Development Center

DoD FUEL CELL DEMONSTRATION PROGRAM

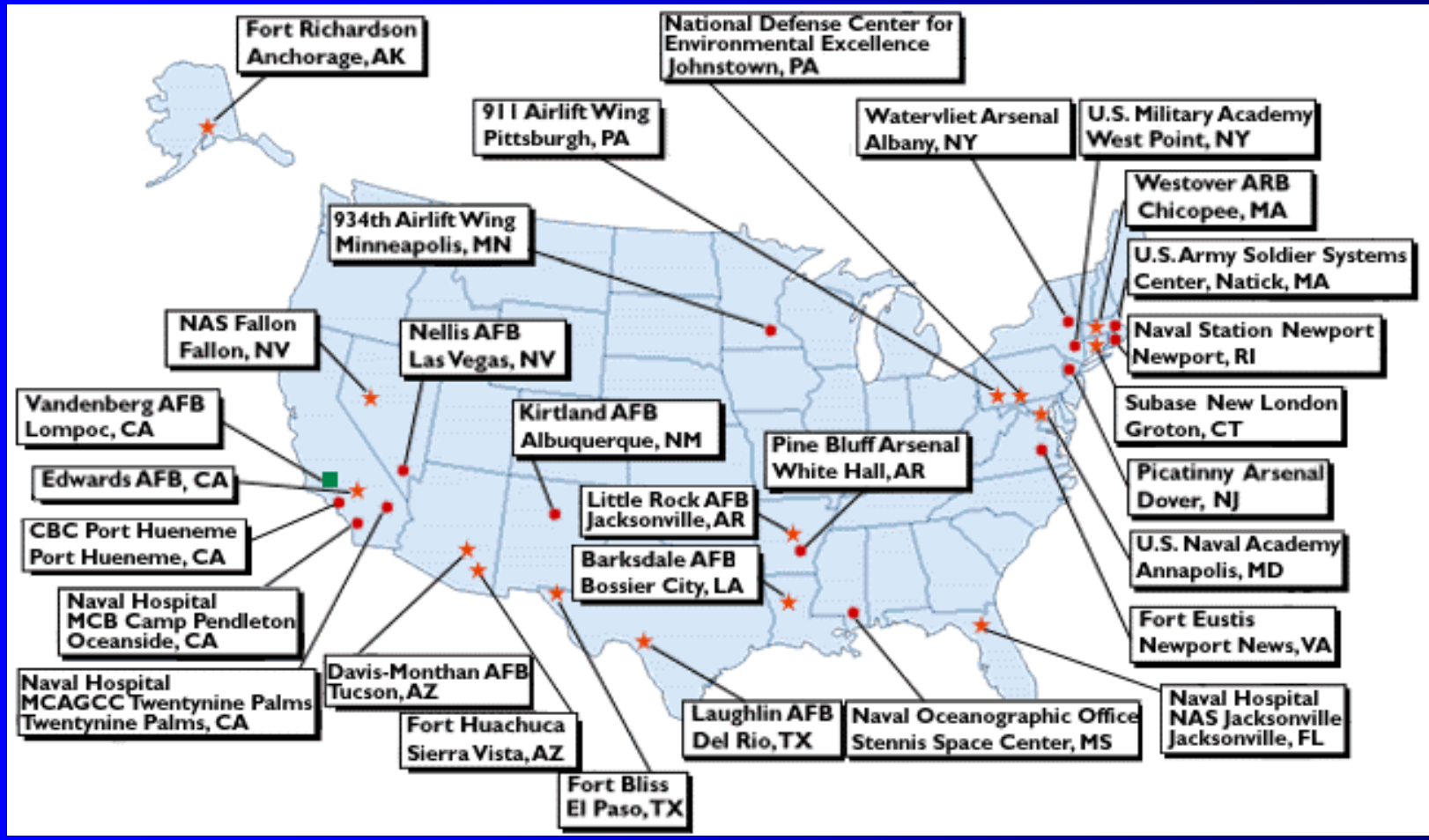
- FY93 Congressional Appropriation - $18M
- FY94 Congressional Appropriation - $18.75M
- Specify “...natural gas fuel cells in production in the United States...”



Turn-key Package

- ONSI PC25 Fuel Cell Power Plant
  - Fy93 - 1 ea. Model A, 11 ea. Model B
  - Fy94 - 3 ea. Model B, 15 ea. Model C
- Engineering Design / Installation
- Training for Site Personnel
- 60 Months Maintenance
- Diagnostic / Remote Monitoring Computer

PC25 POWER PLANT
DoD SITES



PC25A SITE
PC25B SITE
PC25C SITE

US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

Facility Applications

- Central Heat Plants

  11 Sites

- Hospital Utility Plants

  7 Sites

- Pool / Gymnasiums

  3 Sites

- Others

  Barracks, Dining Facility, Laundry, NG Armory, Launch Control Bldg., Office, Evaporator process

FY93 Program Sites

934th Airlift Wing, Minneapolis MN

Kirtland AFB, Albuquerque NM

Nellis AFB, Las Vegas NV

Vandenberg AFB, Lompoc CA

US Army Corps
of Engineers

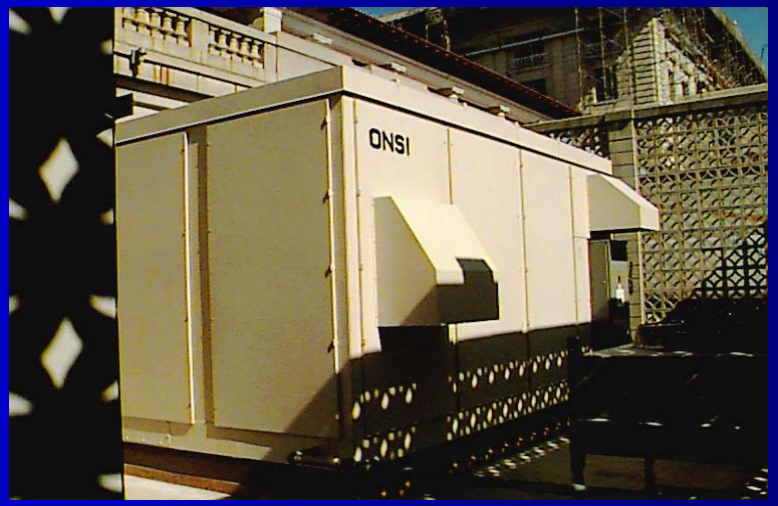
Engineer Research & Development Center

FY93 Program Sites

Naval Hospital, MCAGCC 29 Palms, 29 Palms CA

Naval Hospital, MCB Camp Pendleton, Oceanside CA

Naval Education Training Center, Newport RI



US Naval Academy, Annapolis MD

US Army Corps
of Engineers

Engineer Research & Development Center

FY93 Program Sites

U.S. Army Soldier Systems Command, Natick MA

Ft. Eustis, Newport News VA

Picatinny Arsenal, Dover NJ

U.S. Military Academy, West Point NY

US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

FY94 Program Sites

911th Airlift Wing, Pittsburgh PA

NAS Fallon, Fallon NV

Ft. Richardson, Anchorage AK

Naval Hospital, NAS Jacksonville, Jacksonville FL

US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

FY94 Program Sites

Edwards AFB, CA

Barksdale AFB, Bossier City LA

Ft. Huachuca, Sierra Vista AZ

National Defense Center for Environmental Excellence (NDCEE), Johnstown PA

US Army Corps of Engineers

Engineer Research & Development Center

FY94 Program Sites

CBC Port Hueneme, Port Hueneme CA

Laughlin AFB, Del Rio TX

Naval Oceanographic Office
John C. Stennis Space Center, MS

Westover ARB, Chicopee MA

US Army Corps
of Engineers

Engineer Research & Development Center

FY94 Program Sites

Ft. Bliss, El Paso TX

Subase New London, Groton CT

Little Rock AFB, Jacksonville AR

Pine Bluff Arsenal, White Hall AR

US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

FY94 Program Sites

Watervliet Arsenal, Albany NY

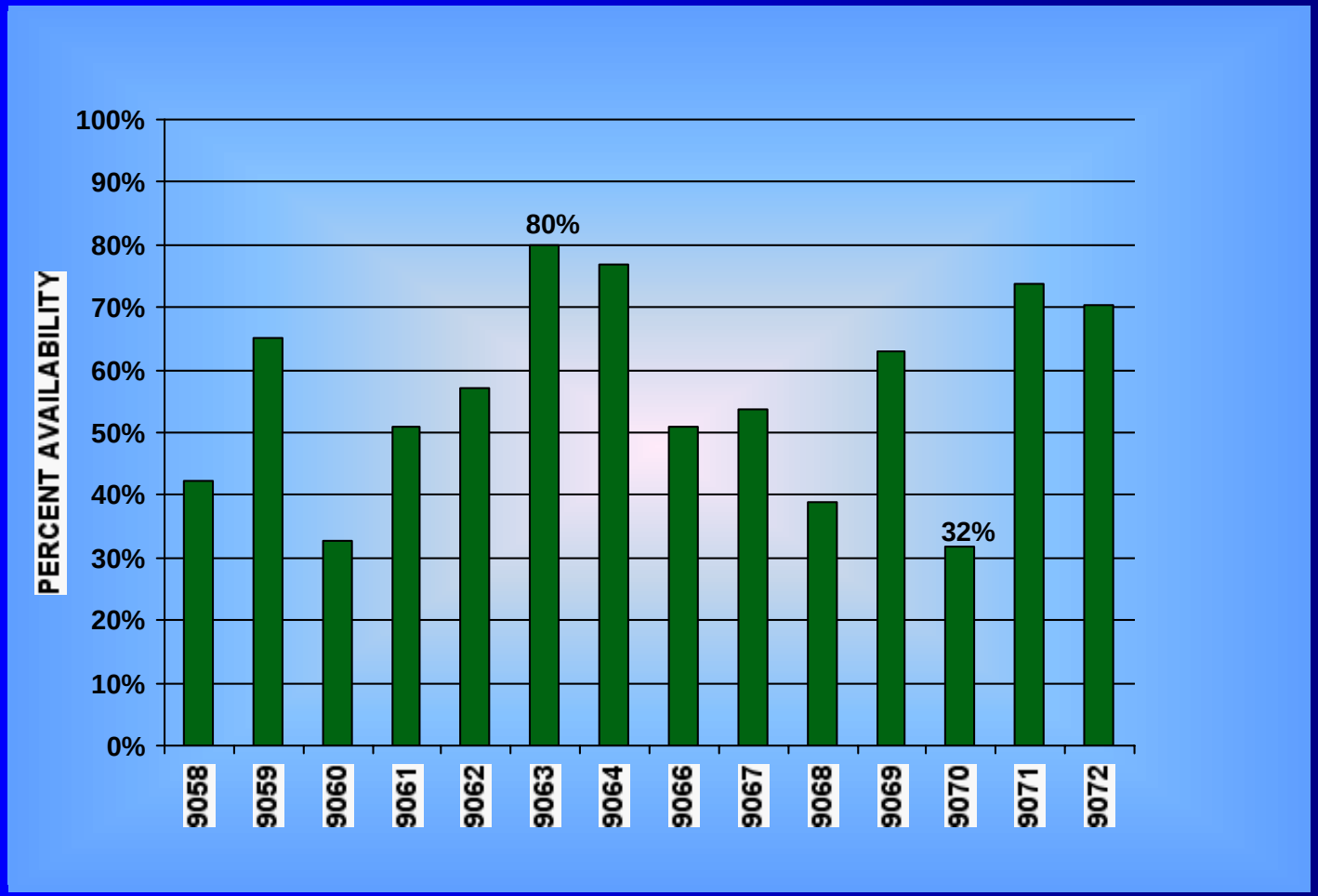
Davis-Monthan AFB, Tucson AZ

Fleet Performance

- Availability
- Outages
- Efficiency
- Cell Voltage
- Current Operating Status

PC25B Availability

Lifelong Average for 14 Sites



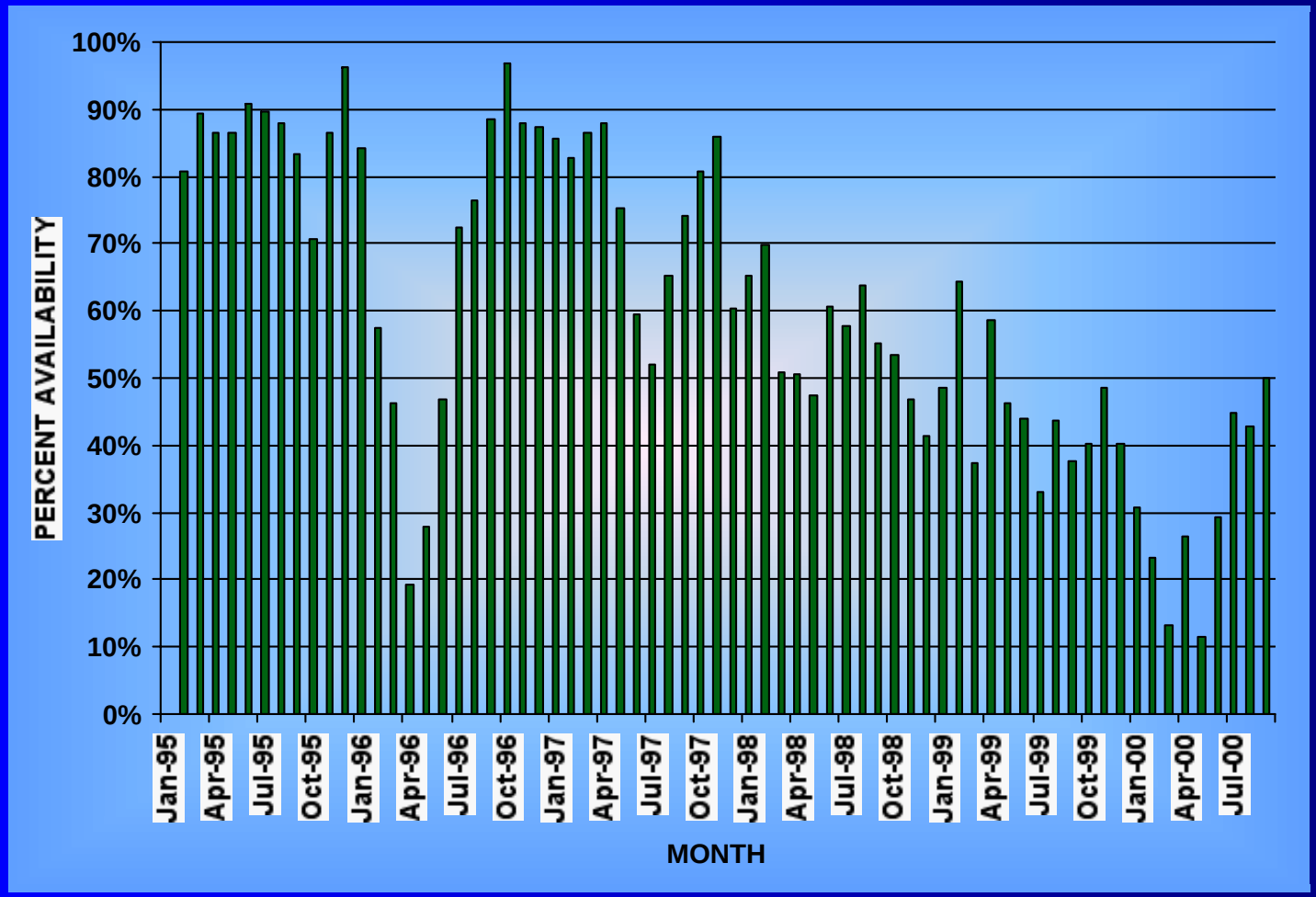
US Army Corps of Engineers

Engineer Research & Development Center

30Jun2000

PC25B Availability

Monthly for Entire B Fleet



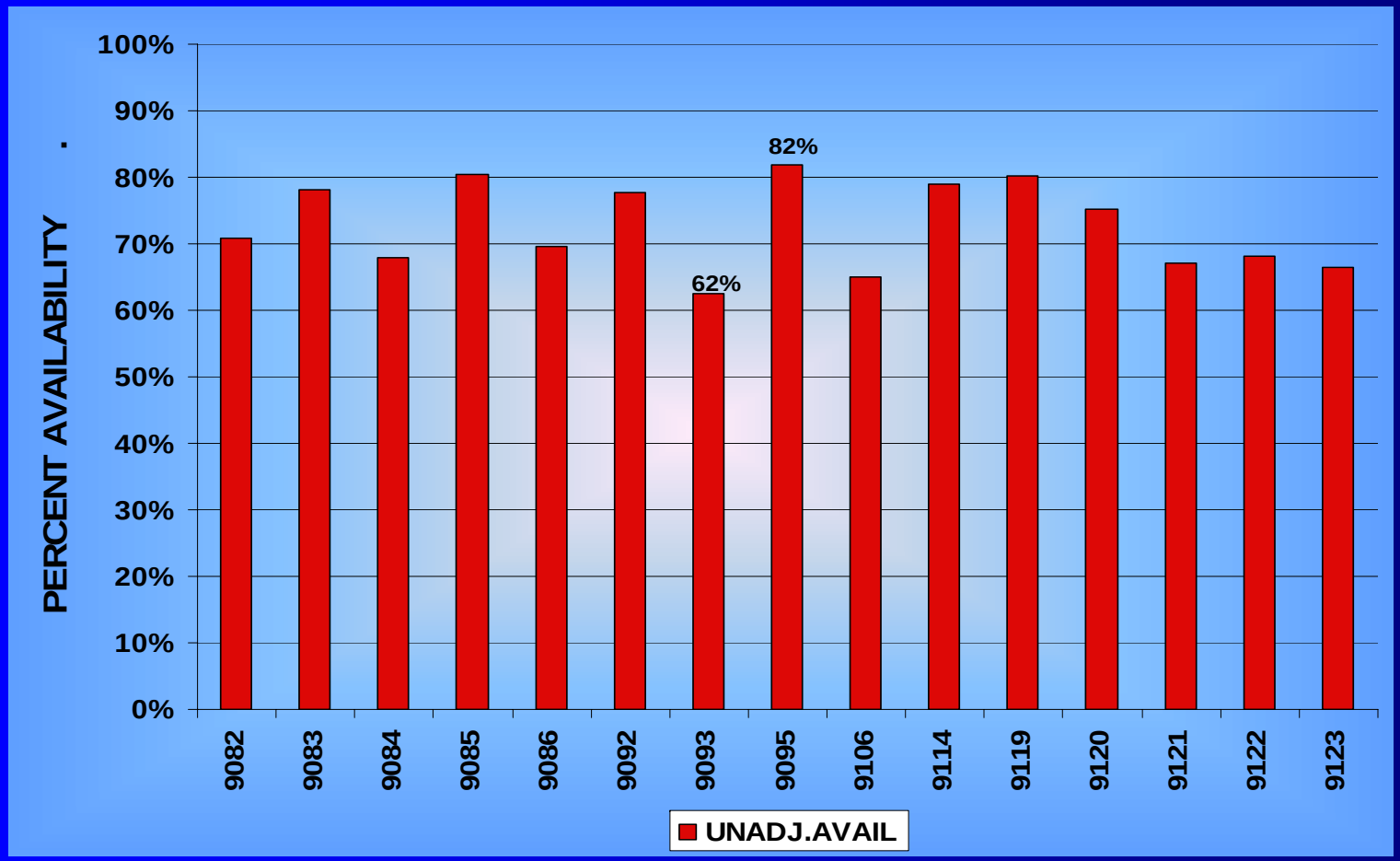
US Army Corps of Engineers

Engineer Research & Development Center

30Jun2000

PC25C Availability

Lifelong Average for 15 Sites



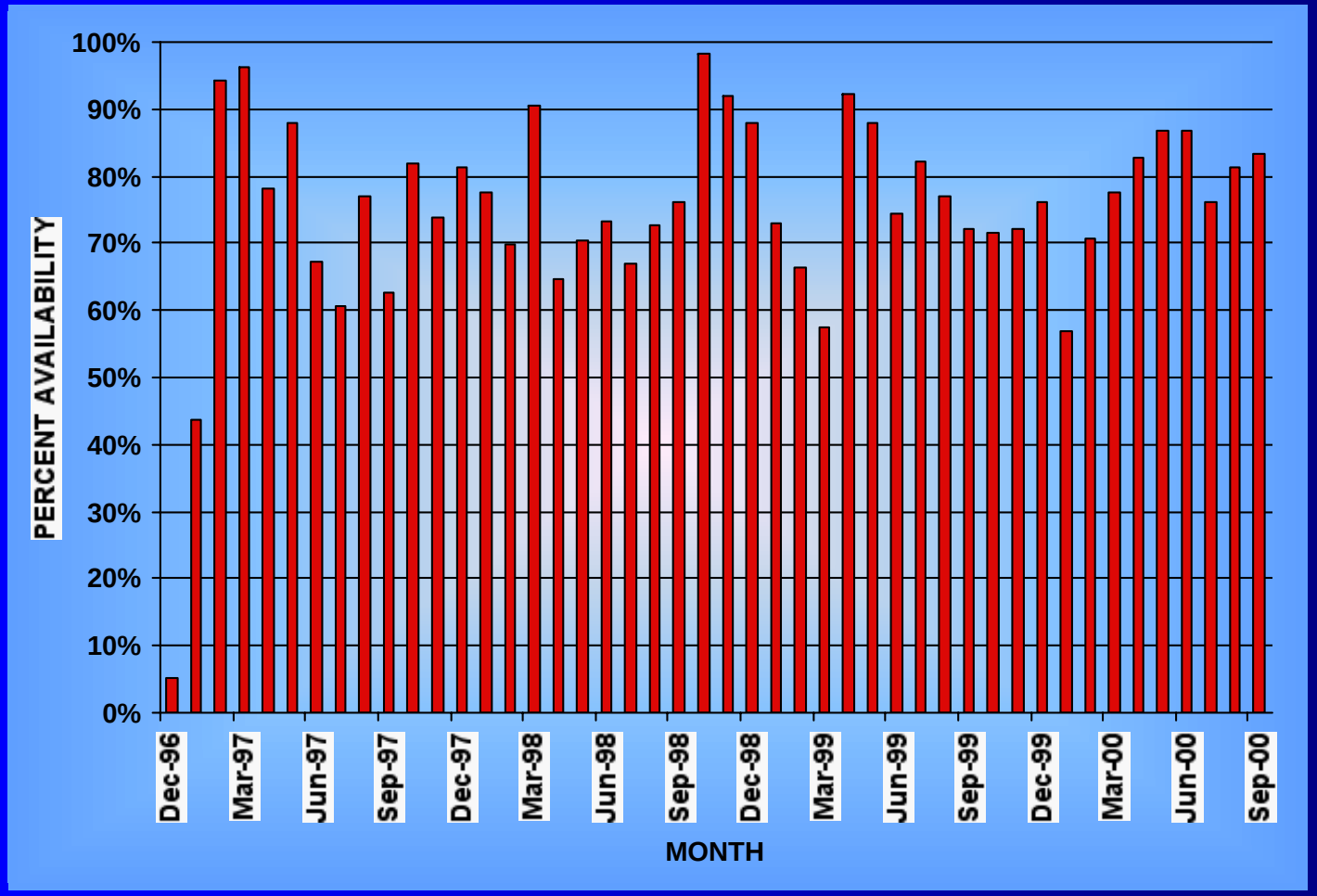
US Army Corps of Engineers

Engineer Research & Development Center

30Jun2000

PC25C Availability

Monthly for Entire C Fleet



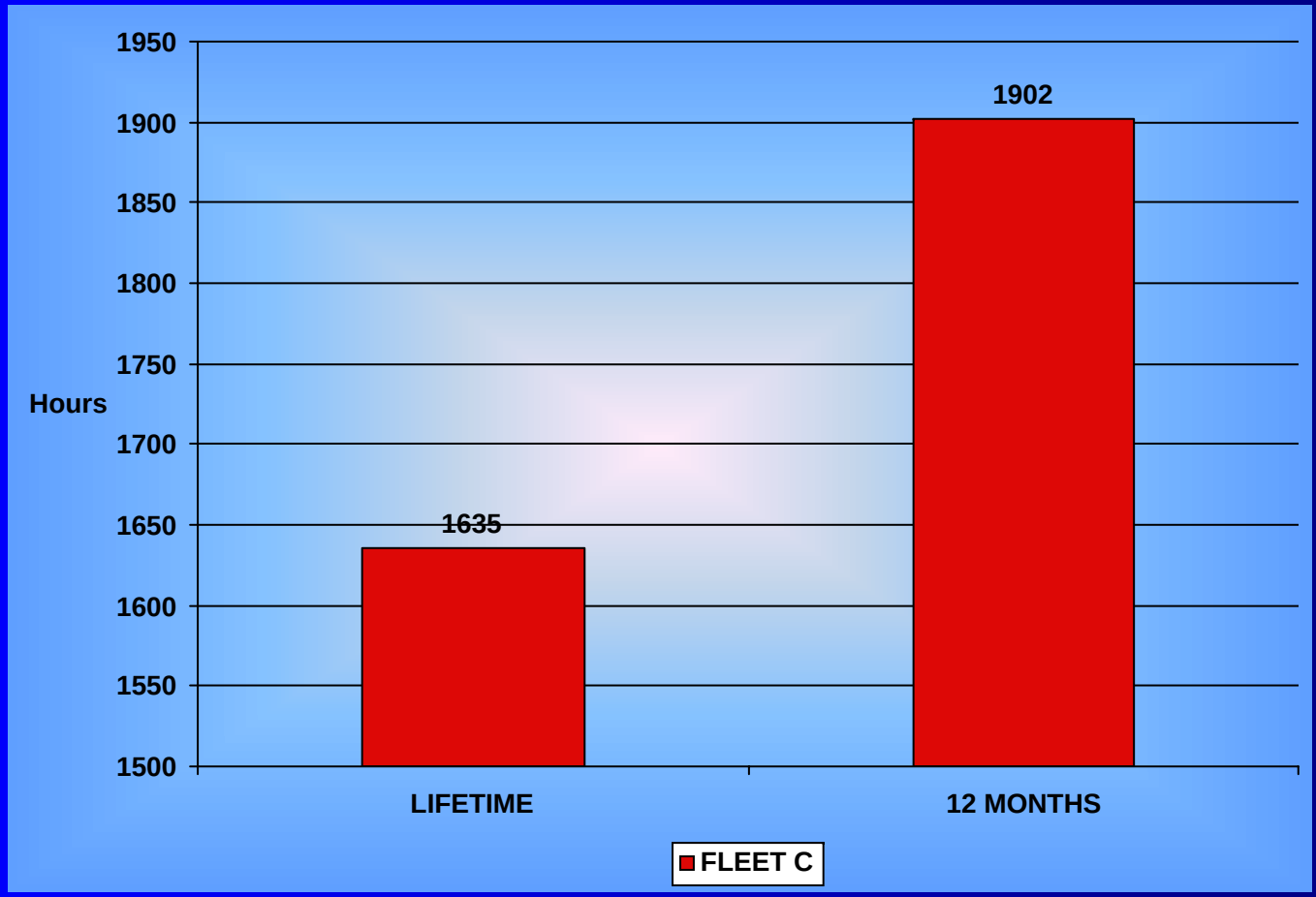
US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

Mean Time Between Forced Outages

(as of Sep 2000)

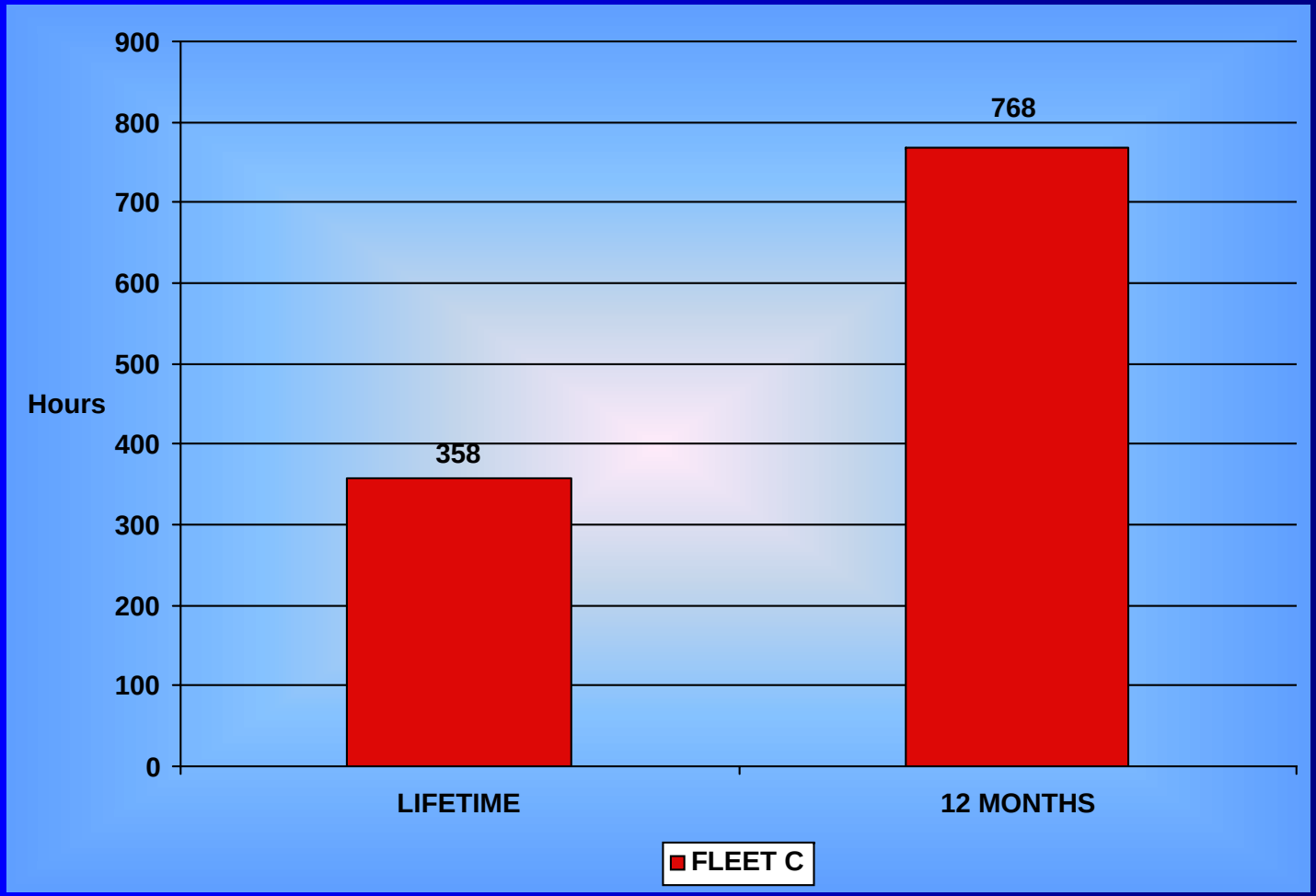


US Army Corps of Engineers

Engineer Research & Development Center

Average Duration of Outage

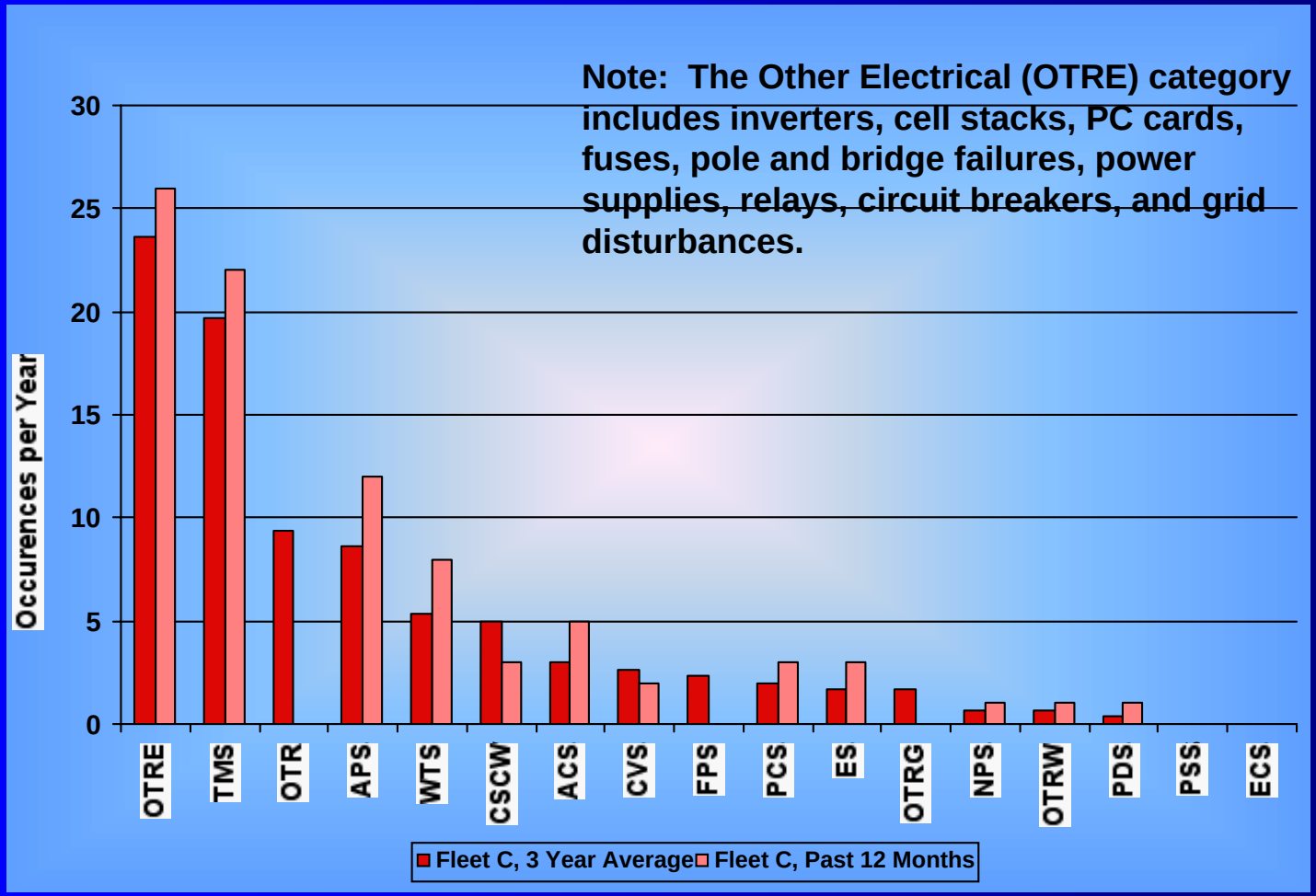
(as of Sep 2000)



US Army Corps
of Engineers

Engineer Research & Development Center

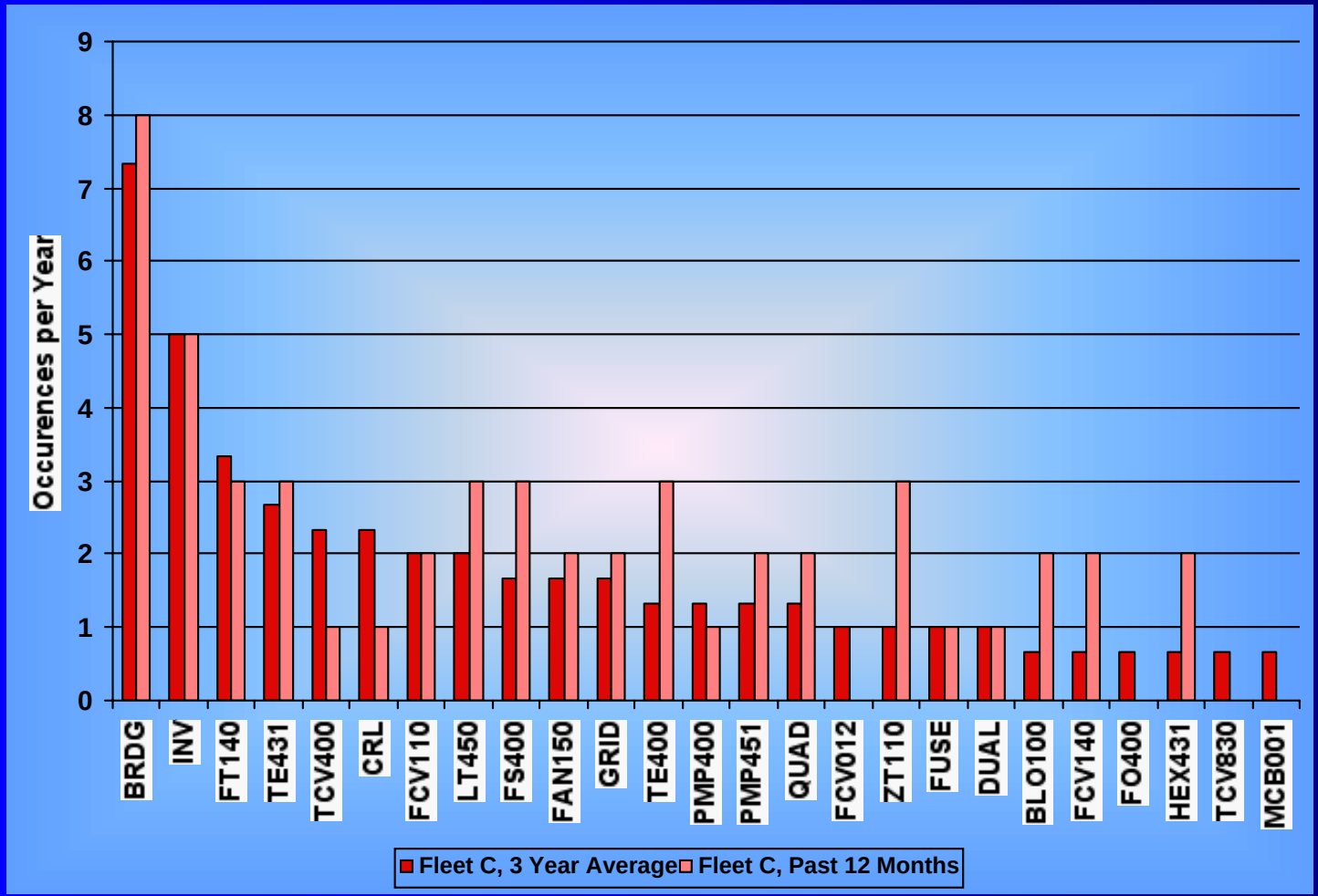
Causes of Forced Outages
By Subsystem



US Army Corps of Engineers

Engineer Research & Development Center

Causes of Forced Outages
By Specific Cause



US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

Efficiency

At initial acceptance, power plants were required to demonstrate an output of 200 kW with a natural gas input of 1900 ±100 cubic feet per hour.

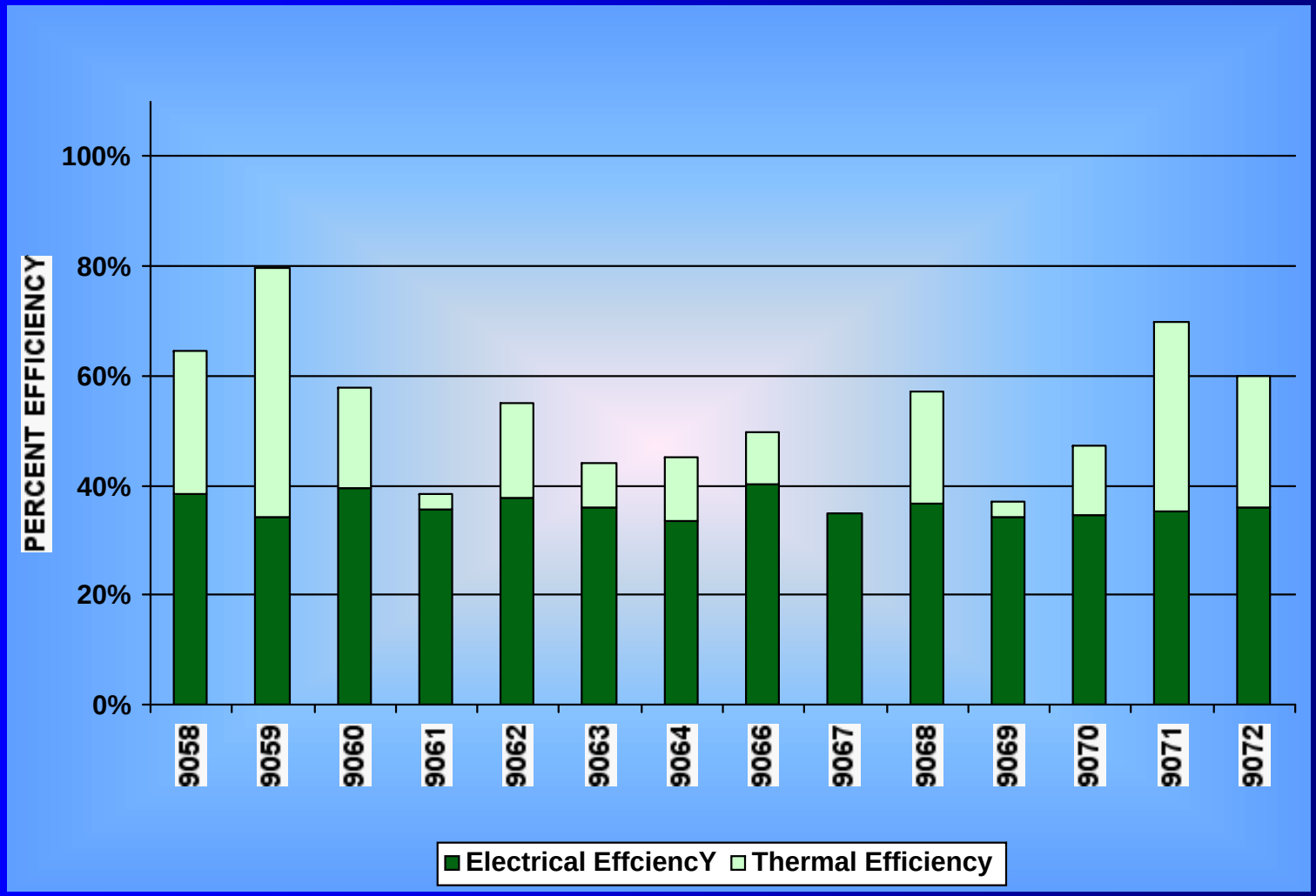
Electrical Efficiency LHV = 39% ± ~2%

HHV = 35% ± ~2%

***based on 925 Btu/cf (LHV) and 1027 Btu/cf (HHV)**

- avg from 10 sites

Fleet B Lifelong Average Efficiency

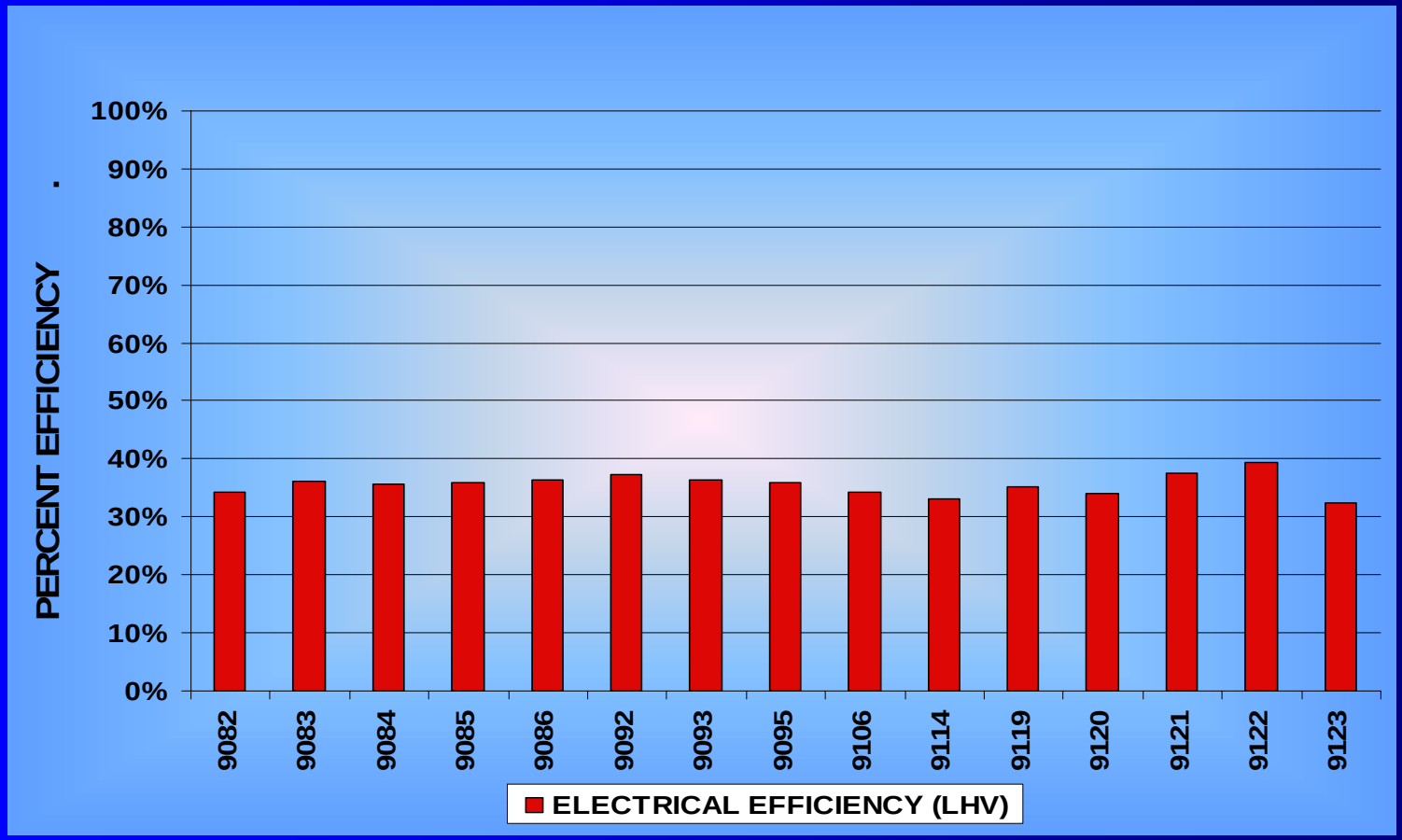


US Army Corps
of Engineers

Engineer Research & Development Center

30Jun2000

Fleet C Electrical Efficiency (LHV) Lifelong Average

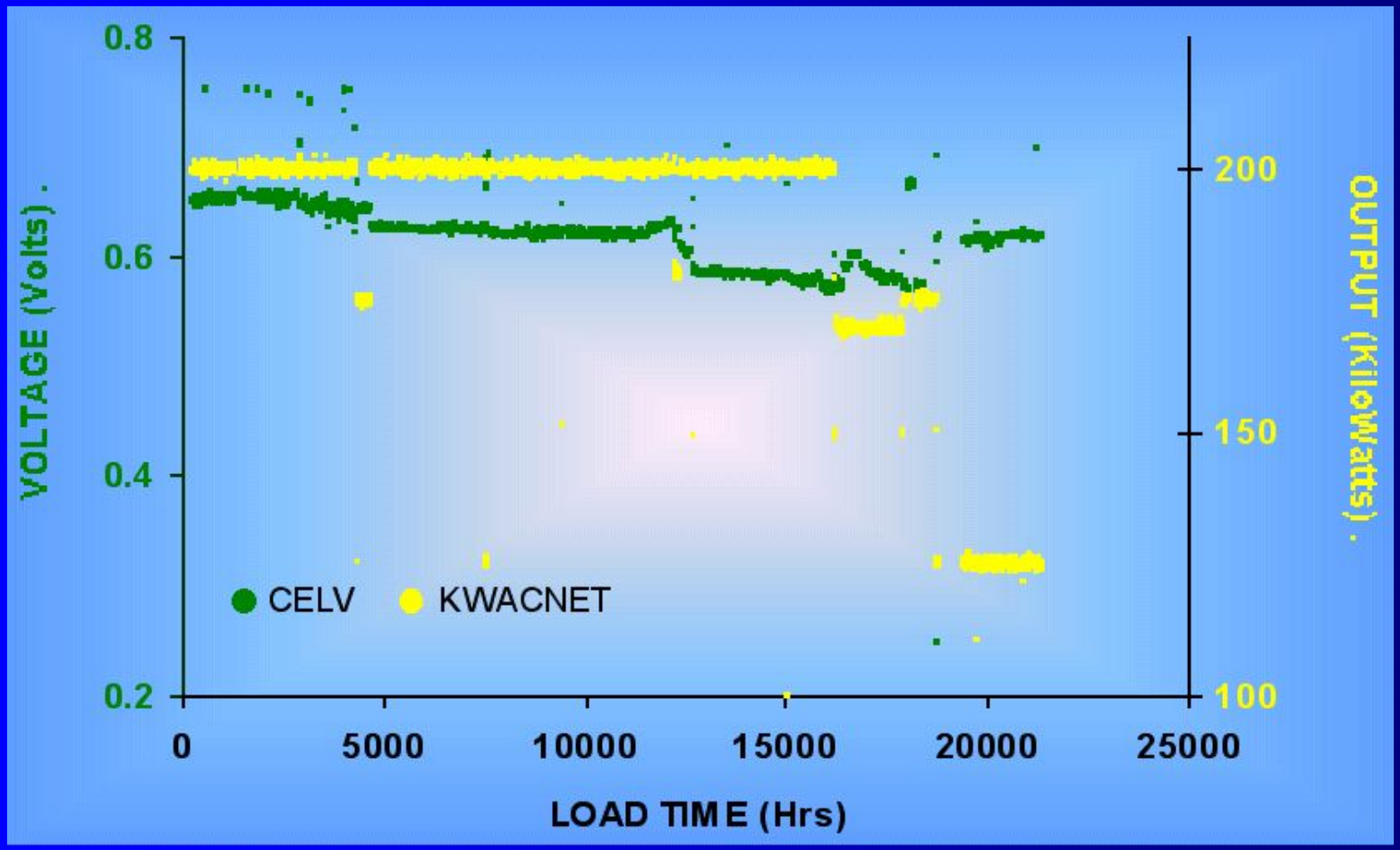


US Army Corps of Engineers

Engineer Research & Development Center

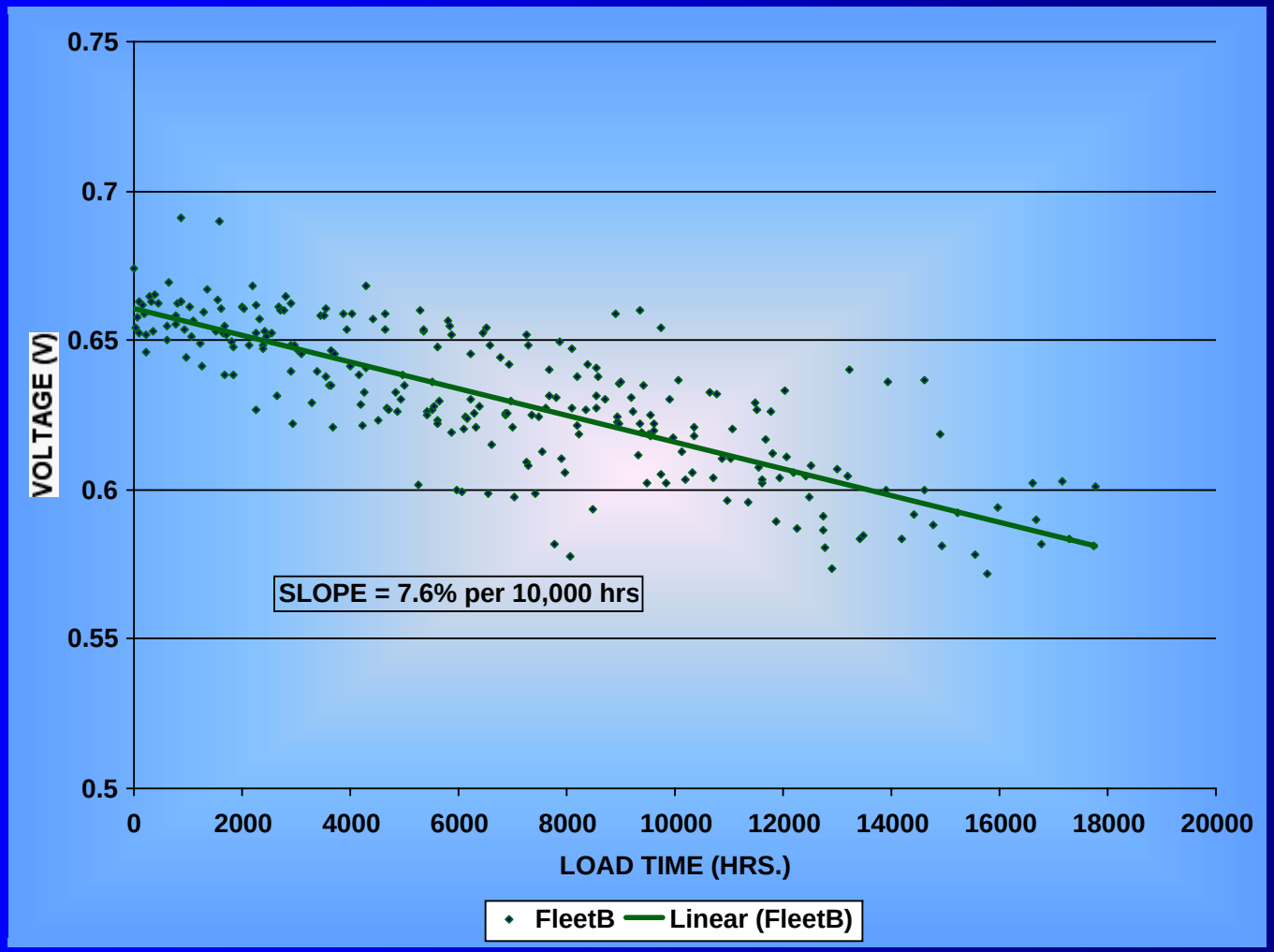
30Jun2000

Average Cell Voltage for SN9059



Average Cell Voltage

B Fleet



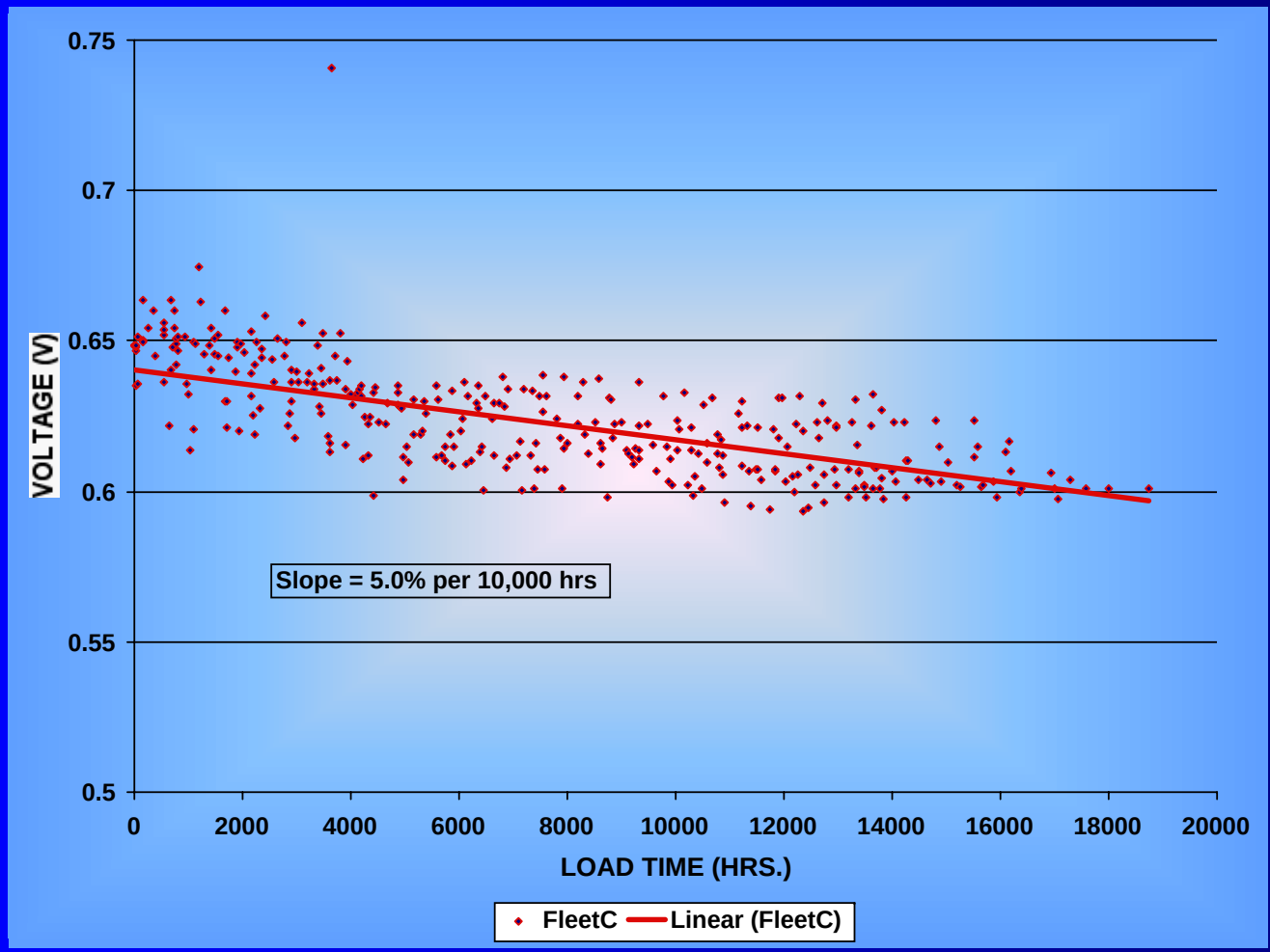
US Army Corps of Engineers

Engineer Research & Development Center

30Jun2000

Average Cell Voltage

C Fleet



US Army Corps
of Engineers

Engineer Research & Development Center

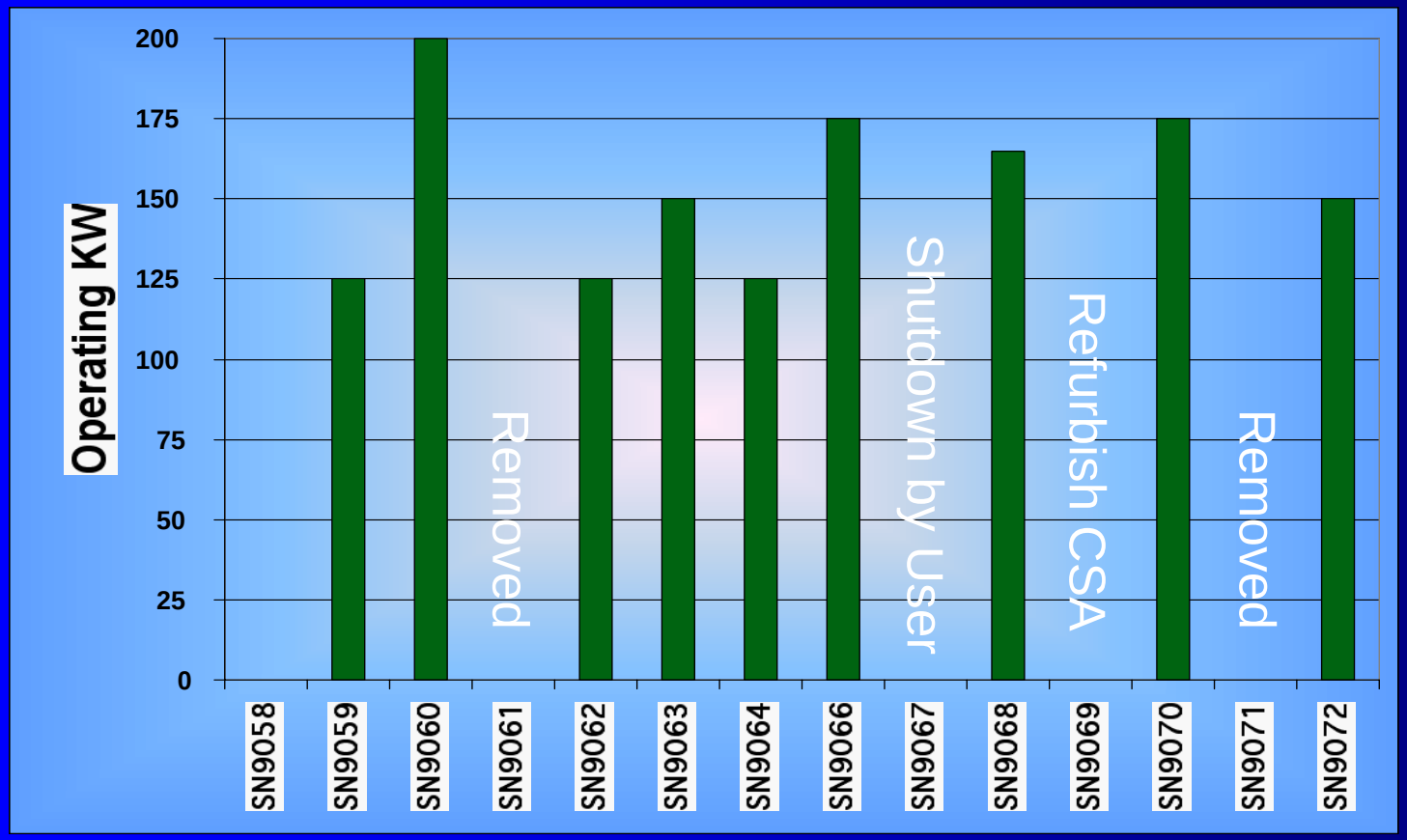
30Jun2000

B Fleet Events

- **5 Cell Stacks Replaced**
  - SN9061, Jan96 at 4K Op.Hrs
  - SN9068, May97 at 9K Op.Hrs
  - SN9060, Dec97 at 3K Op.Hrs
  - SN9062, Feb98 at 13K Op.Hrs
  - SN9070, Feb98 at 13K Op.Hrs
- **2 Units Shutdown for Removal**
- **1 Unit Shutdown by User**
- **1 Unit CSA Refurbishment (exp.)**

PC25B Current Status

As of Sep 2000



$$\text{AVG Operating KW} = \frac{45740\ \text{MWH}}{296245\ \text{RunHrs}} = 154\ \text{KW}$$

US Army Corps of Engineers

Engineer Research & Development Center

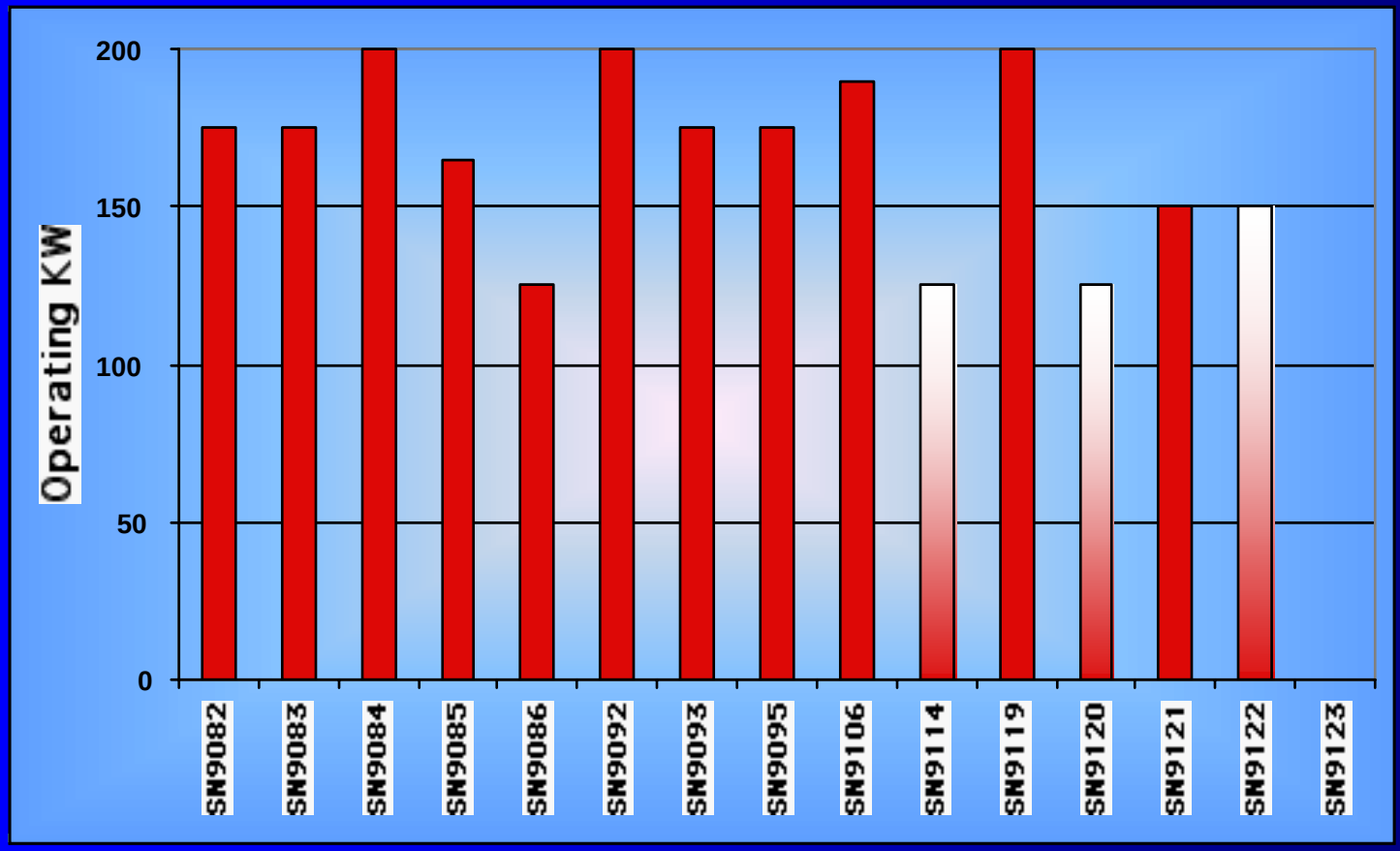
30Jun2000

C Fleet Events

- **2 Cell Stacks Replaced**
  - SN9121, Oct97 at 2K Op.Hrs
  - SN9093, Aug99 at 15K Op. Hrs
- **3 CSA Replacements Planned**
- **SN9123 Rebuilt**

PC25C Current Status

As of June 2000



$$\text{AVG Operating KW} = \frac{56238\ \text{MWH}}{317051\ \text{RunHrs}} = 177\ \text{KW}$$

US Army Corps of Engineers

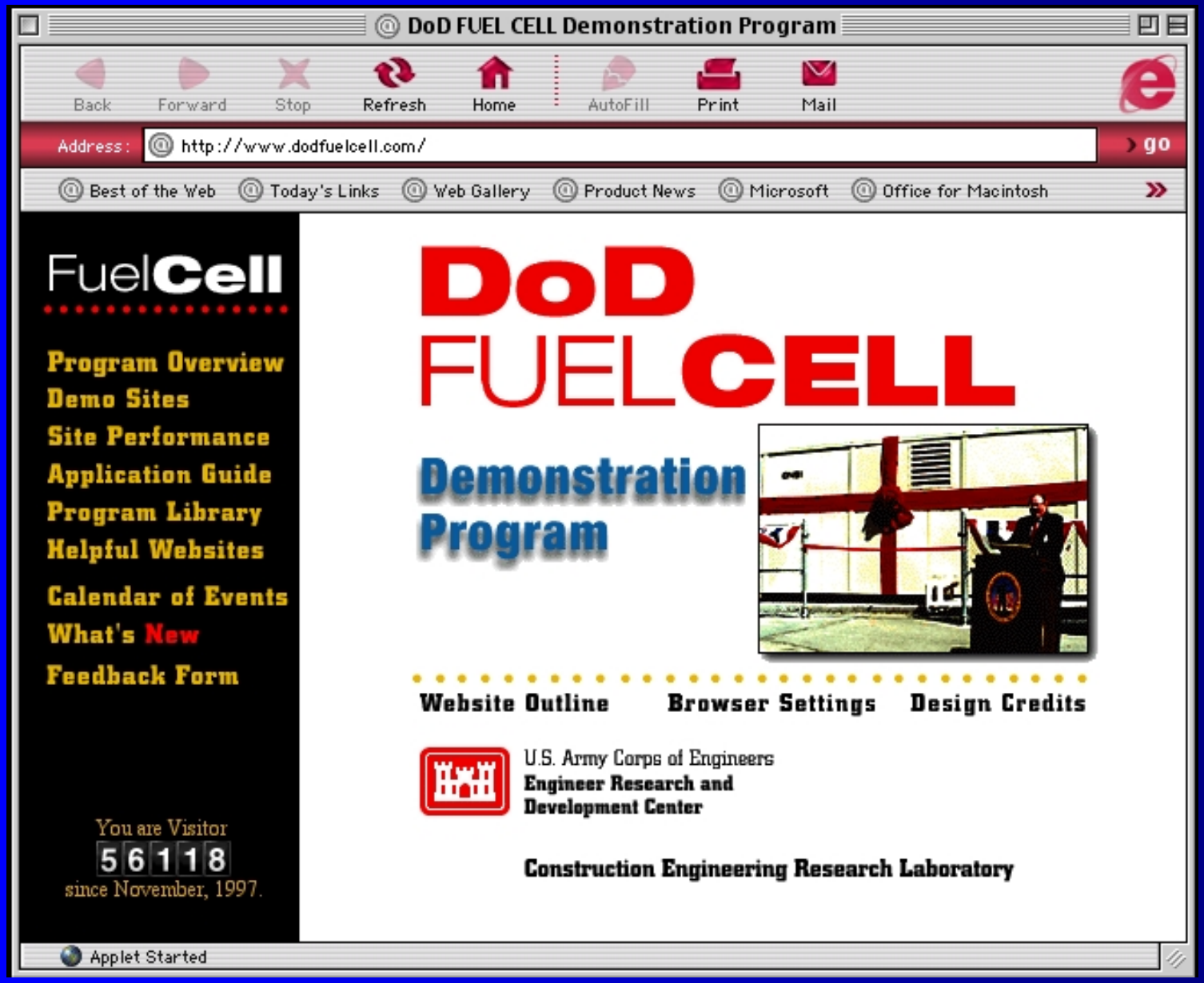
Engineer Research & Development Center

30Jun2000

Fleet Performance Summary

(29 Power Plants)
As of 1 September 2000

• Total Run Time	614,658 hrs
• Availability	
Model B Fleet	56%
Model C Fleet	77%
Last 6 months	83%
• Energy $ Saved	$4,144,645
• NOx Abated	197 tons
• SOx Abated	422 tons
• CO Abated	17 tons
• CO_2 Abated	25,001 tons


DoD FUEL CELL Demonstration Program
Back
Forward
Stop
Refresh
Home
AutoFill
Print
Mail
Address:
http://www.dodfuelcell.com/
go
Best of the Web
Today's Links
Web Gallery
Product News
Microsoft
Office for Macintosh
FuelCell
Program Overview
Demo Sites
Site Performance
Application Guide
Program Library
Helpful Websites
Calendar of Events
What's New
Feedback Form
You are Visitor
56118
since November, 1997.
DoD
FUELCELL
Demonstration
Program
Website Outline
Browser Settings
Design Credits
U.S. Army Corps of Engineers
Engineer Research and
Development Center
Construction Engineering Research Laboratory
Applet Started